Info 206: Computing

Lecture 6

Networking and Internet Freedom

September 22, 2014

Random Walks Over the Web

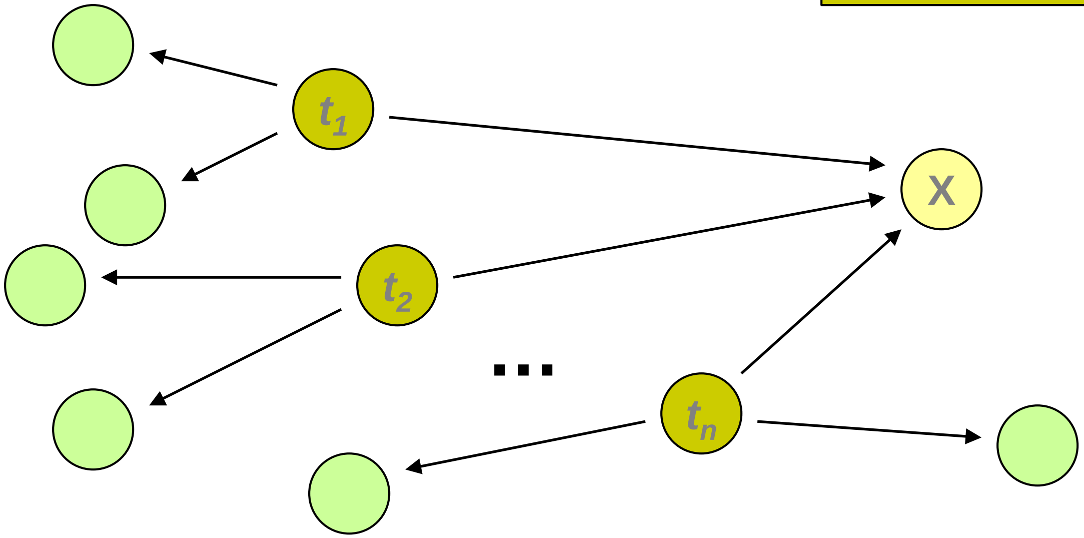
- Model:
    - User starts at a random Web page
    - User randomly clicks on links, surfing from page to page
- How much time is spent on each page?
- This is PageRank (named after Larry Page)

PageRank: Defined

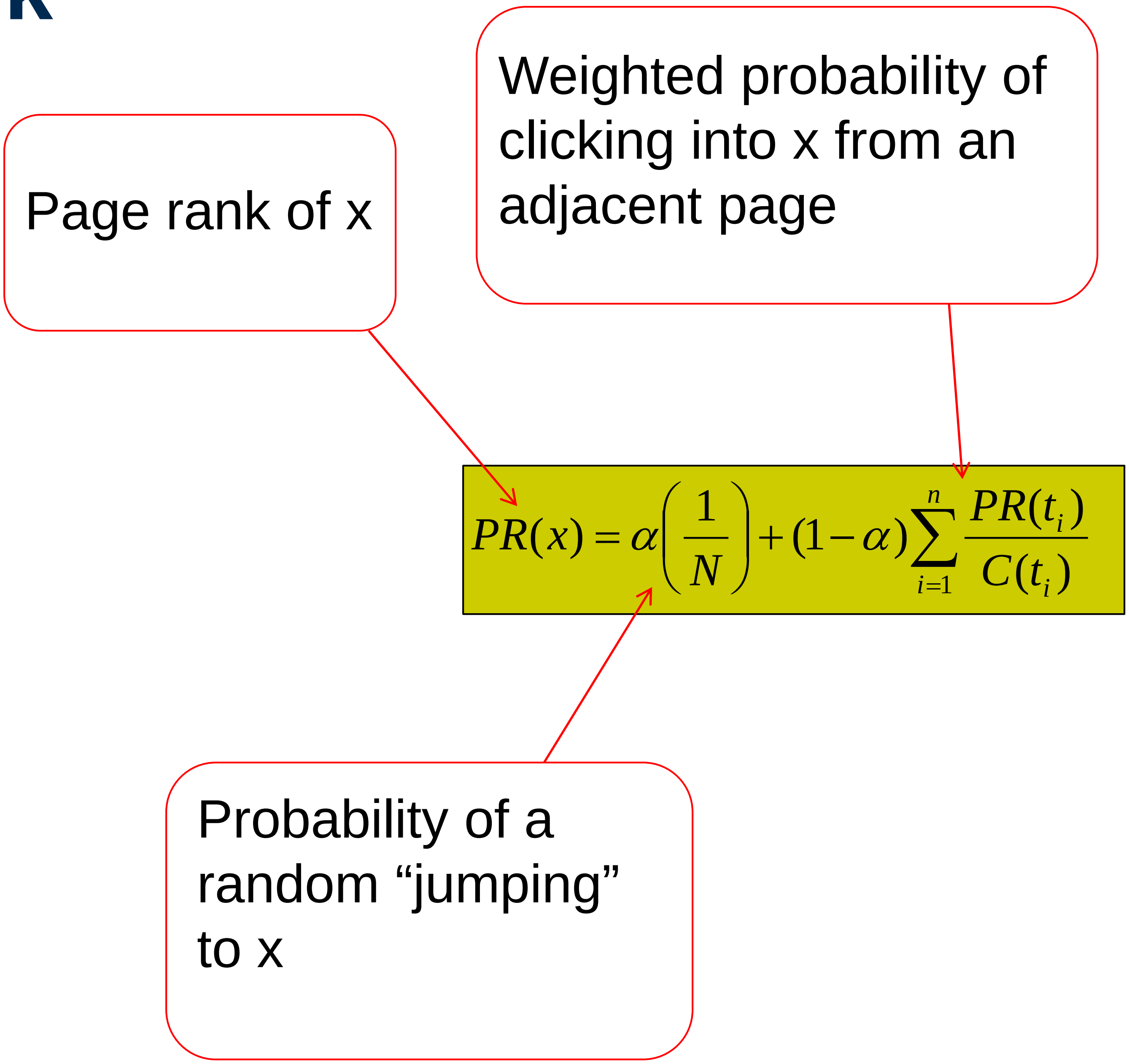
Given page *x* with in-bound links $t_1 \ldots t_n$, where

- $C(t)$ is the out-degree of t
- α is probability of random jump
- N is the total number of nodes in the graph

$$PR(x) = \alpha\left(\frac{1}{N}\right) + (1-\alpha)\sum_{i=1}^{n}\frac{PR(t_i)}{C(t_i)}$$



PageRank



Page rank of x

Weighted probability of clicking into x from an adjacent page

$$PR(x) = \alpha\left(\frac{1}{N}\right) + (1-\alpha)\sum_{i=1}^{n}\frac{PR(t_i)}{C(t_i)}$$

Probability of a random “jumping” to x

Computing PageRank

- Properties of PageRank
  - Can be computed iteratively
  - Effects at each iteration is local
- Sketch of algorithm:
  - Start with seed PR_i values
  - Each page distributes PR_i “credit” to all pages it links to
  - Each target page adds up “credit” from multiple in-bound links to compute PR_{i+1}
  - Iterate until values converge

Understanding Networking: OSI Model

	Layer Name	Description	Examples
➡	Application	User Level Processing	HTTP, FTP, Mail
	Presentation	Data Representation & Syntax	ISO Presentation
	Session	Sync Points and Dialogs	ISO Session
➡	Transport	Reliable End to End	TCP
➡	Network	Unreliable Thru Multi-Node Network	X.25 Pkt, IP
	Link	Reliable Across Physical Line	LAPB, HDLC
	Physical	Unreliable Wire, Telco Line	RS232, T1, 802.x

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IP/TCP

- Backbone protocol of Internet
- Internet Protocol
  - Moves packets from one location to another
- Transmission Control Protocol
  - Assures reliable reconstruction of data
  - Packets in order, no missing packets

IP version 4

- Addresses on Internet defined by four bytes
- ischool.berkeley.edu = 128.32.78.26
  - Handles many communications simultaneously
  - Needs “ports” to disambiguate
  - Port 22: SSH (secure shell)
  - Port 23: Telnet
  - Port 80: HTTP (web)
- Mapping from “domain names” to IP
  - Domain Name Service

TCP key issues

- Reliable communications
- Packets guaranteed to arrive in correct order

IP/TCP communication

- Defined by five values
  - Source IP address
  - Source port
  - Destination IP address
  - Destination port
  - Protocol (TCP is the most important one)

Other information

- Time to live
  - How long a packet can survive
  - Tracert
- Sequence numbers
  - Packets arrive in order
- Acknowledgement numbers
- Checksums
  - Make sure packet data uncorrupted

TCP handshake

A → B: SYN (synchronize)

B → A: SYN-ACK (synchronize & acknowledge)

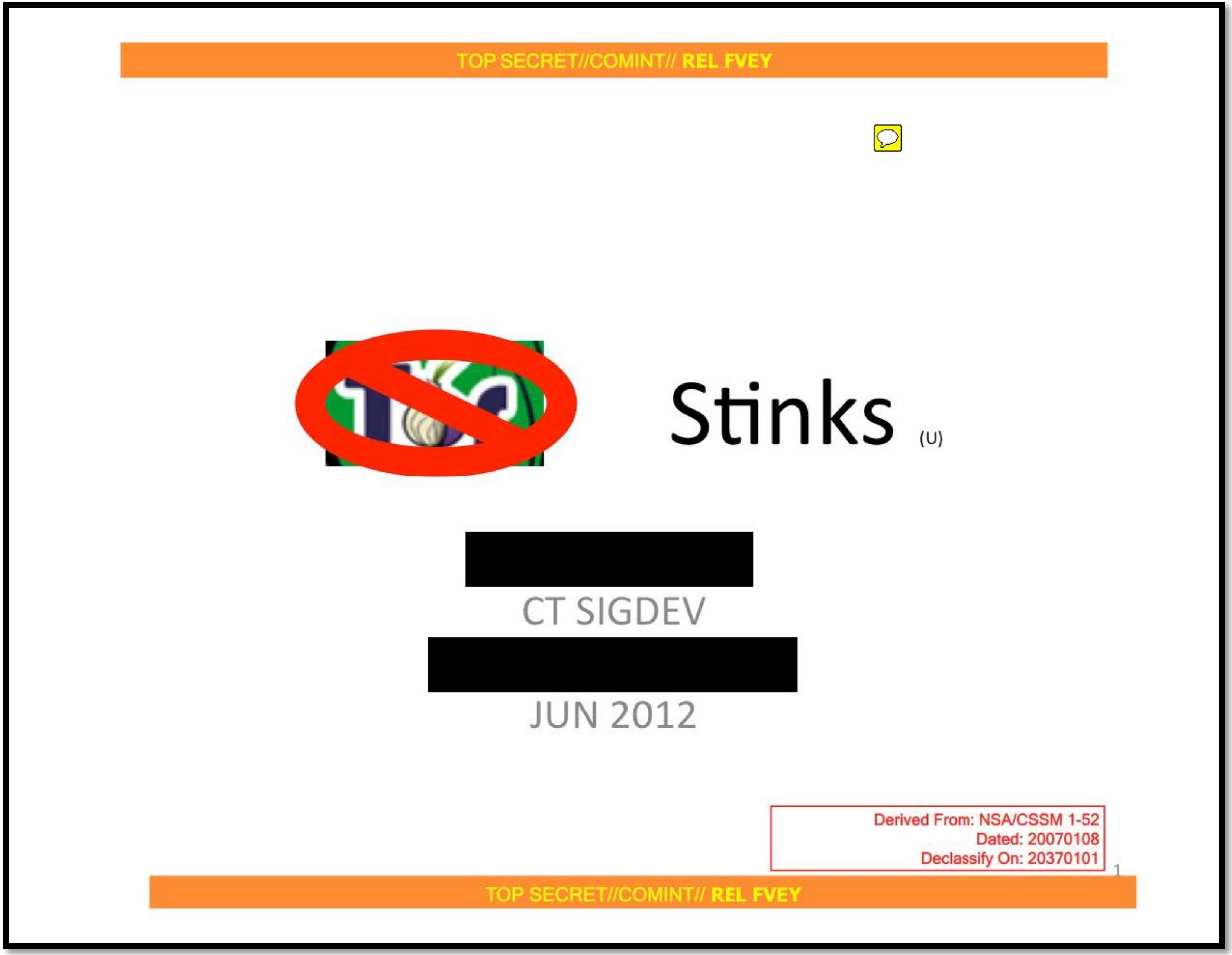
A → B: ACK (acknowledge)

Backbone protocol of the Internet

Internet Freedom

- Some countries censor access to Internet
  - Bahrain, Belarus, China, Cuba, Ethiopia, Iran, North Korea, Oman, Pakistan, Qatar, Saudi Arabia, Sudan, Syria, Turkmenistan, UAE, Uzbekistan, Vietnam, Yemen
- To address these concerns, users turn to *circumvention* programs (such as Tor, Freegate, Ultrasurf)

NSA: Tor stinks



TOP SECRET//COMINT// **REL FVEY**

Stinks (U)

[redacted]

CT SIGDEV

[redacted]

JUN 2012

Derived From: NSA/CSSM 1-52
Dated: 20070108
Declassify On: 20370101

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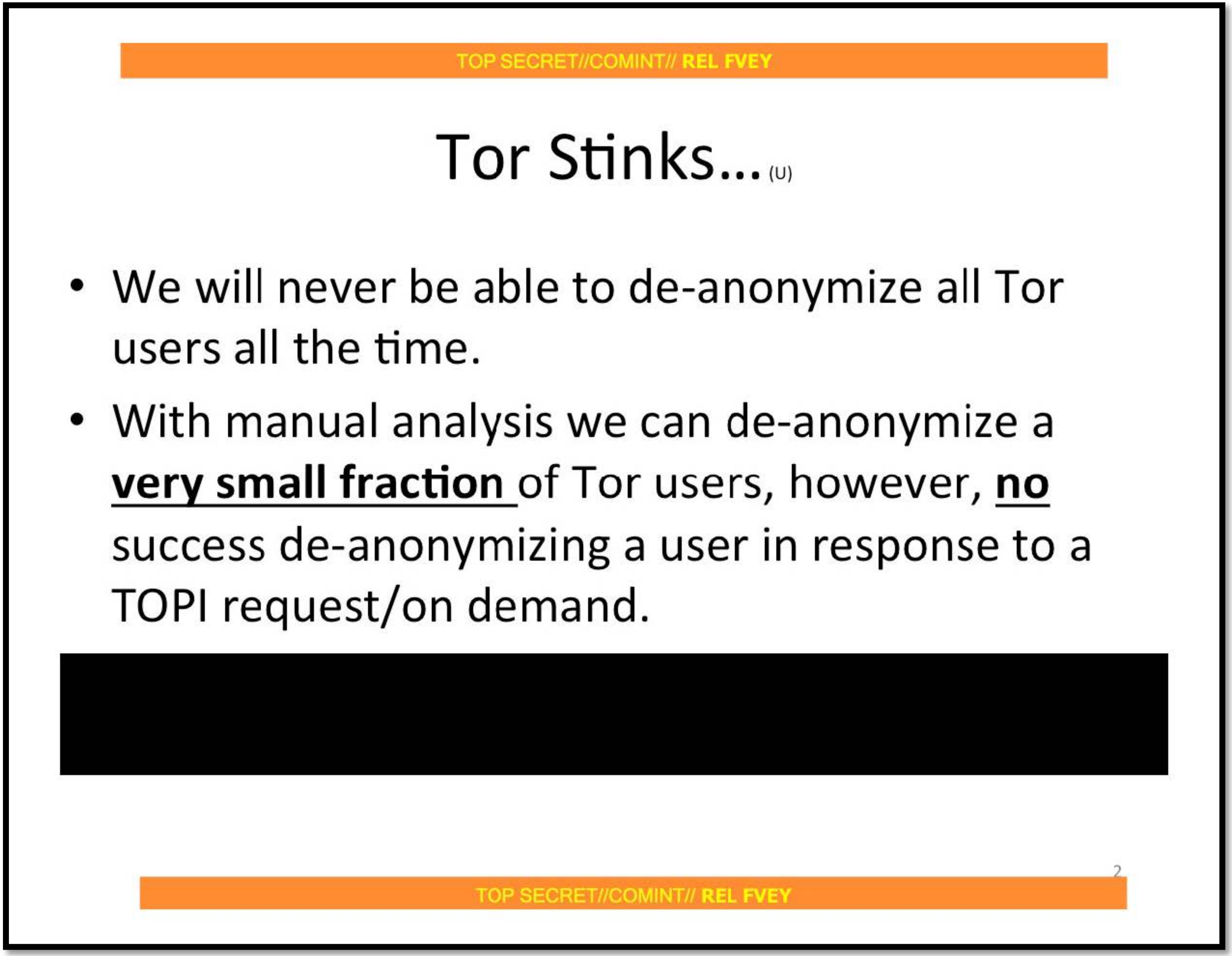
TOP SECRET//COMINT// **REL FVEY**

NSA: Tor stinks



TOP SECRET//COMINT// **REL FVEY**

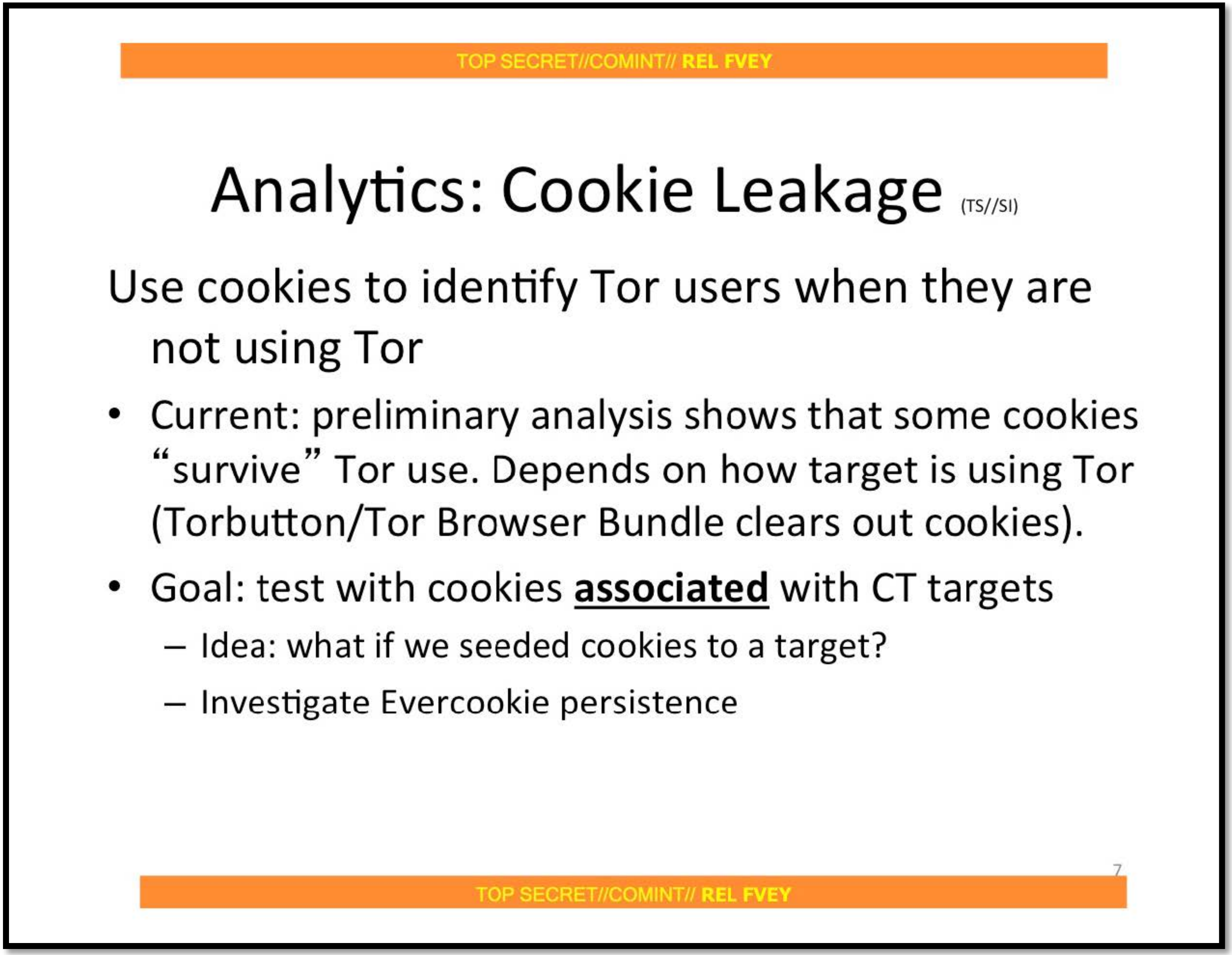
Tor Stinks… (U)

- We will never be able to de-anonymize all Tor users all the time.
- With manual analysis we can de-anonymize a **very small fraction** of Tor users, however, **no** success de-anonymizing a user in response to a TOPI request/on demand.

[redacted]

TOP SECRET//COMINT// **REL FVEY**

NSA: Tor stinks



TOP SECRET//COMINT// **REL FVEY**

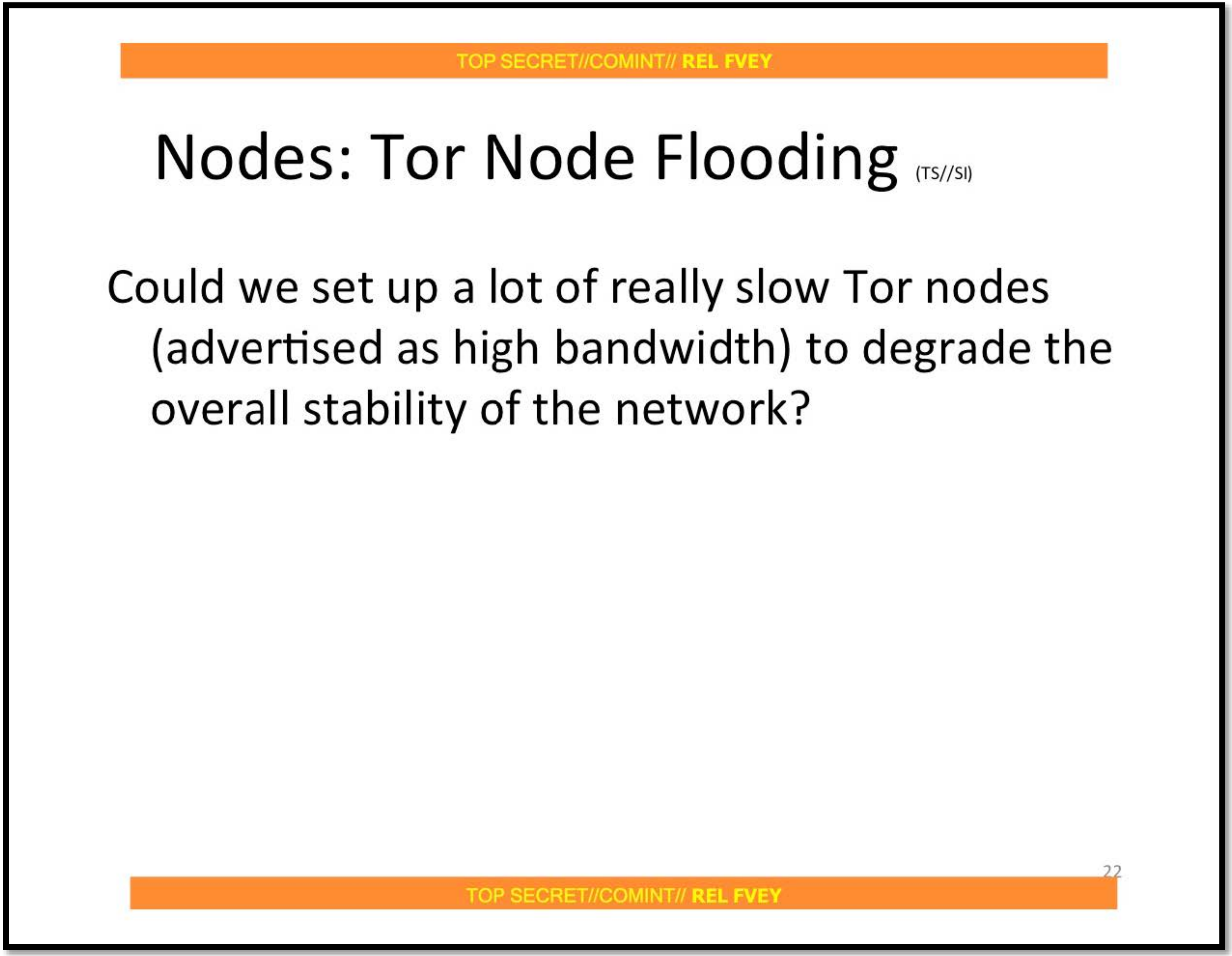
Analytics: Cookie Leakage (TS//SI)

Use cookies to identify Tor users when they are not using Tor

- Current: preliminary analysis shows that some cookies "survive" Tor use. Depends on how target is using Tor (Torbutton/Tor Browser Bundle clears out cookies).
- Goal: test with cookies **associated** with CT targets
  - Idea: what if we seeded cookies to a target?
  - Investigate Evercookie persistence

TOP SECRET//COMINT// **REL FVEY**

NSA: Tor stinks



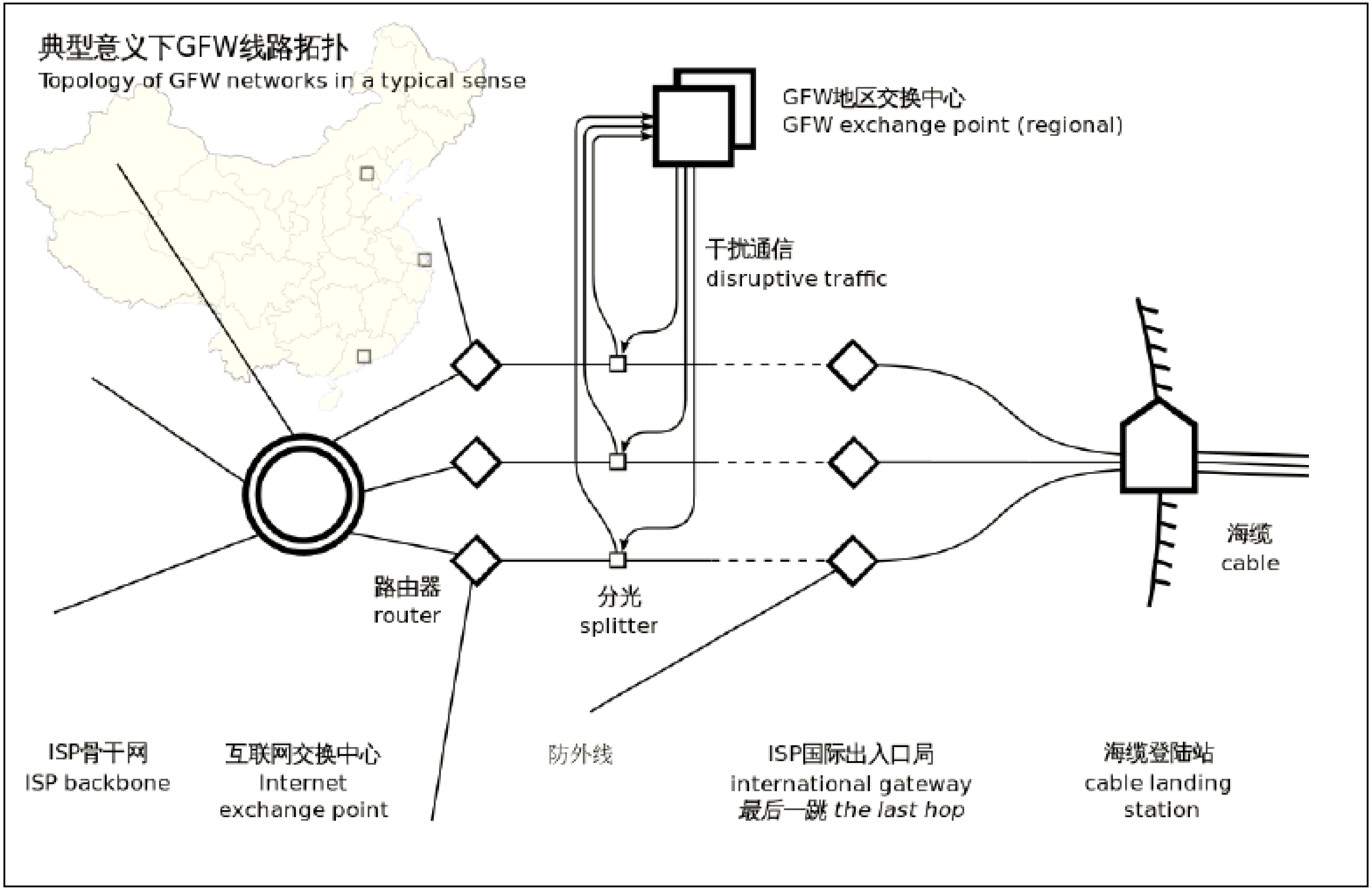
Nodes: Tor Node Flooding (TS//SI)

Could we set up a lot of really slow Tor nodes (advertised as high bandwidth) to degrade the overall stability of the network?

Basic censorship techniques

- Blacklisting IP addresses
    - ISP blocks a certain set of IP addresses
    - IP addresses may be circumvention tool
        - e.g., Tor nodes
    - IP addresses may be forbidden content
        - e.g., (dalailama.com)
- DNS poisoning
    - Mess up DNS lookup for certain domains
- Reset
    - Send a special TCP RST packet
    - Causes both sides to drop TCP connection

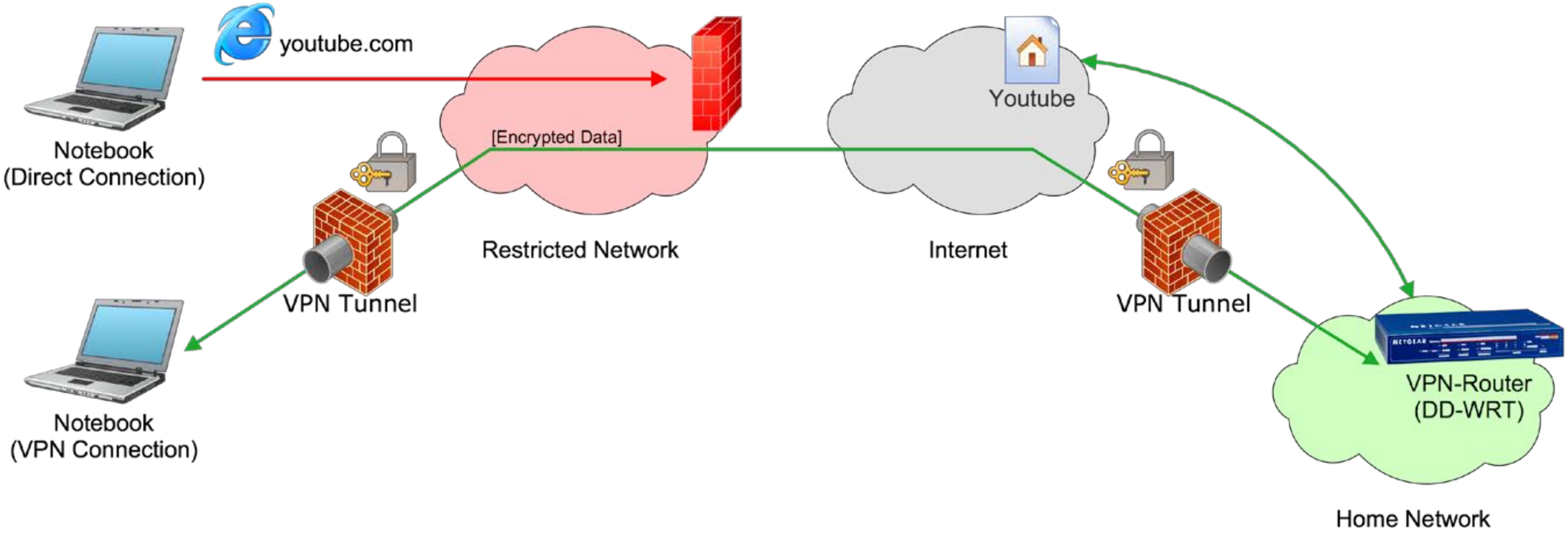
“Great Chinese Firewall”



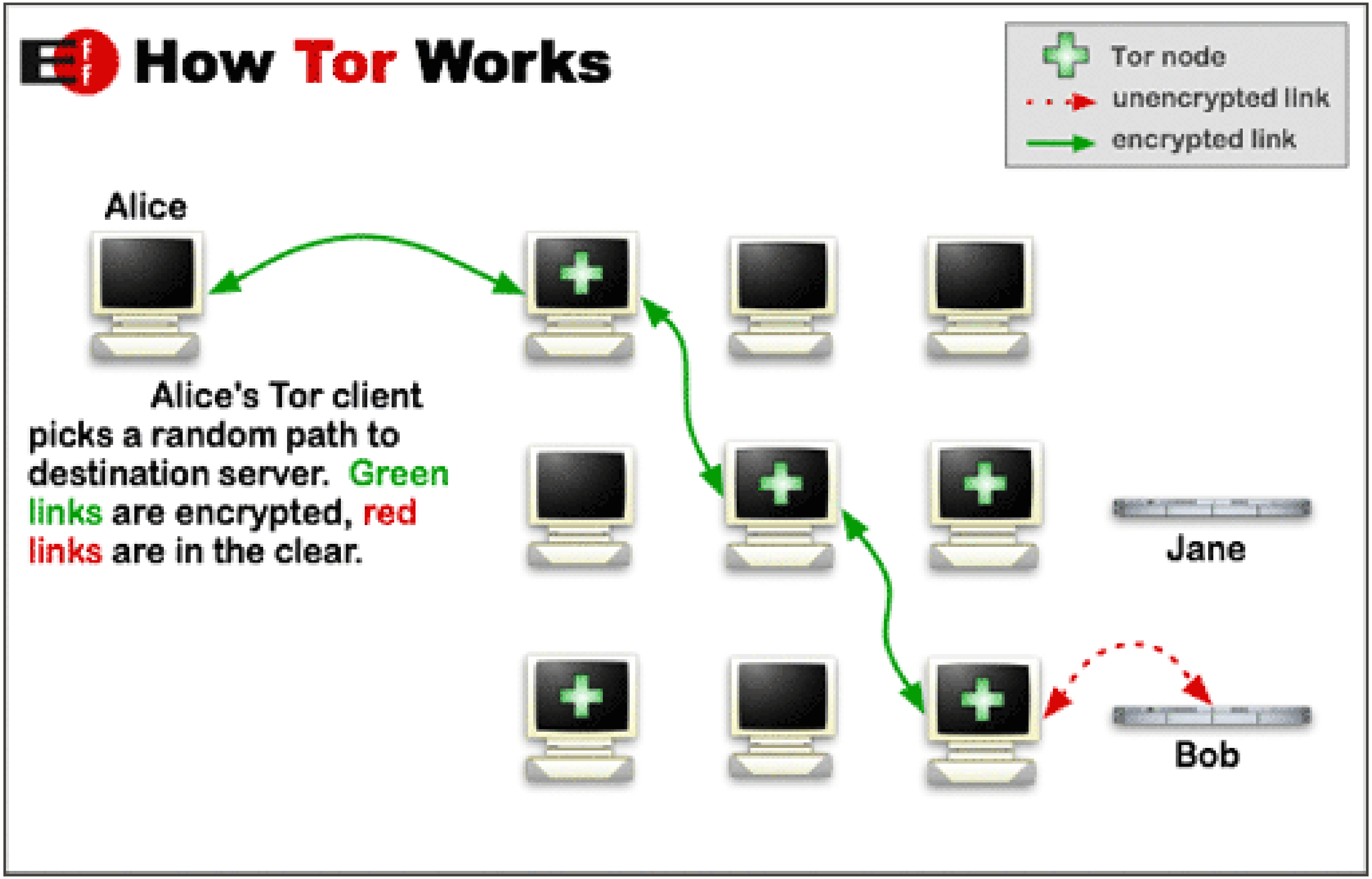
Circumvention needs

- Access
  - Just want to get to Youtube
- Privacy
  - Avoid surveillance
  - Key technology: encryption

One hop proxies/VPN



Multihop proxies (Tor)


How Tor Works
Tor node
unencrypted link
encrypted link
Alice
Alice's Tor client picks a random path to destination server. Green links are encrypted, red links are in the clear.
Jane
Bob

Tor usage

The anonymous Internet

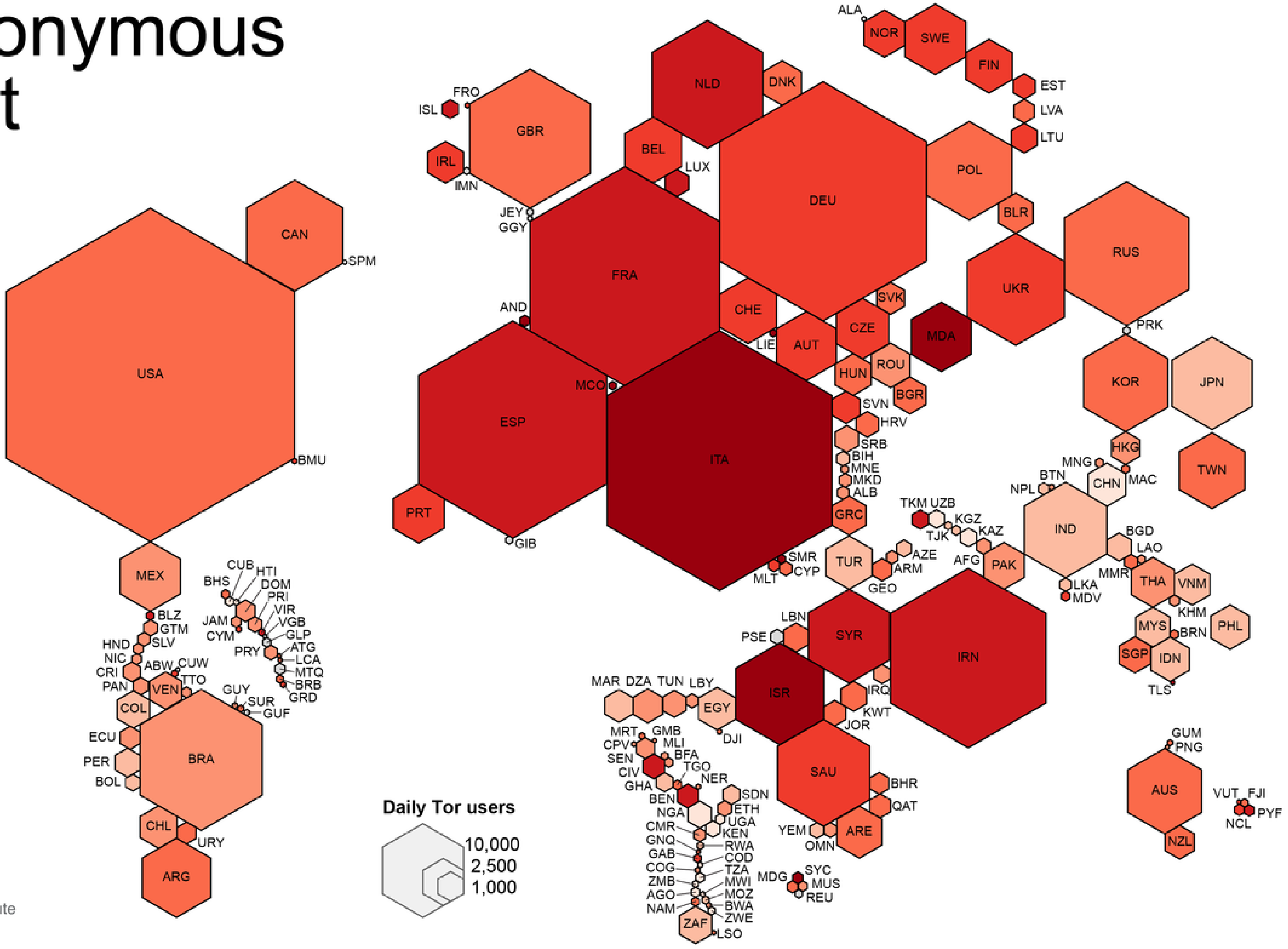
Daily Tor users per 100,000 Internet users

- 🟥 > 200
- 🟥 100 - 200
- 🟥 50 - 100
- 🟥 25 - 50
- 🟥 10 - 25
- 🟥 5 - 10
- □ < 5
- □ no information

Average number of Tor users per day calculated between August 2012 and July 2013

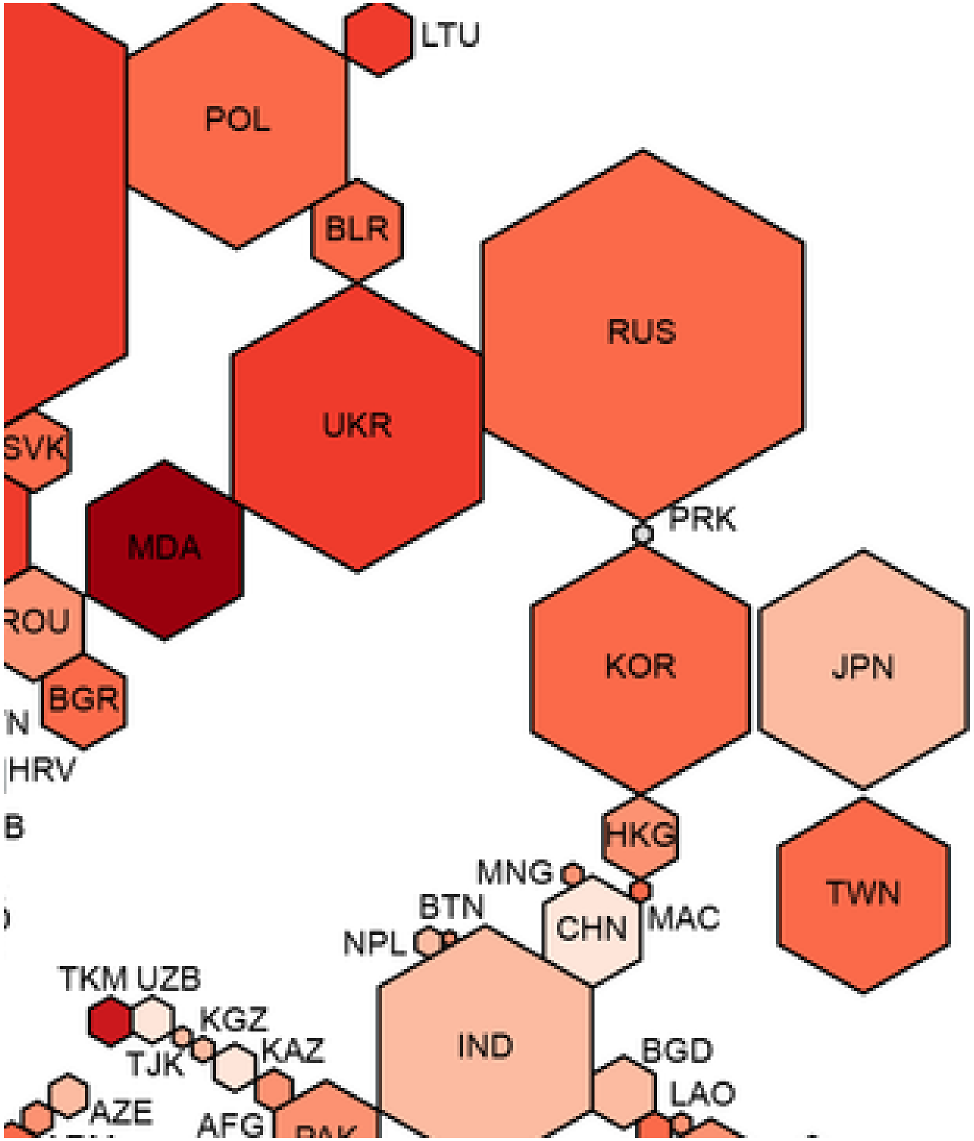
data sources:
Tor Metrics Portal
metrics.torproject.org
World Bank
data.worldbank.org

by Mark Graham (@geoplace) and Stefano De Sabbata (@maps4thought)
Internet Geographies at the Oxford Internet Institute
2014 • geography.oii.ox.ac.uk



Oxford Internet Institute
University of Oxford

Tor usage


LTU
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CHN
MAC
TWN
NPL
TKM
UZB
KGZ
TJK
KAZ
IND
BGD
AZE
LAO
AFG

Why isn’t Tor used more in China?

- Short answer: it doesn’t work
- Tor nodes (IP addresses) are discovered & blocked
- Tor protocol has “signature” allowing it to be blocked